REMARKS

This is in response to the Office Action mailed on April 4, 2005. In the Office Action, the Examiner indicated that Claims 1-28 are pending, Claims 1-6, 8-22, 25-28 are rejected, and Claims 7, 23-24 are objected to as being dependent on a rejected base claim. Applicant would like to thank the Examiner for the indicated allowability of Claims 7, 23-24. Applicant respectfully requests reconsideration and allowance of the remaining claims in view of the following remarks.

Claim Rejections - 35 USC 103

Claims 1-6, 8-22, and 25-28 were rejected under 35 USC 103(a) over Carey et al. (US 2003/0022023) in view of Shimizu et al. (US 2002/0004148).

In making the rejection, the Examiner wrote "With respect to the claim limitation directed to a magnetic moment greater than 1.7 T, it is the Examiner's contention that the CoFe soft magnetic layers taught by Carey et al. inherently satisfy the limitation by virtue of the fact that magnetic moment is a material property and applicants teach using the same material."

In "Response to Remarks," the Examiner suggested that the reference cited by applicant in the last office action did not address the specific magnetic material property (magnetic moment) set forth in the claims. The textbook cited (Giacoletto) indicated that that magnetic material properties, generally, were known to depend on annealing conditions, but did not expressly show an example of such dependency for a numerical value of magnetic moment.

A particular numerical value of magnetic moment, however, is not inherent to the composition of a soft magnetic material. The Examiner has not provided any scientific reasoning or support for the assertion that a magnetic moment greater than 1.7 T is inherent to a particular material composition, and has not

provided support for the assertion that magnetic moment does not depend on annealing conditions. The Examiner is requested to withdraw the rejection based on these assertions of personal knowledge, or provide an affidavit which supports the assertions of personal knowledge that a magnetic moment greater than 1.7 T is inherent to a particular material composition and that magnetic moment does not depend on annealing conditions. See 37 CFR 1.104(d)(2). In this regard, the Examiner's attention is invited to FIG. 10.2 on page 360 of Introduction to Magnetic Materials, B.D. Cullity (Addison-Wesley 1972), ISBN 0-201-01218-9, Chapter 10, Section 10.2 Magnetic Annealing, pages 357-360. In FIG. 10.2, the vertical axes are in the CGS units of gauss. It is well known in the art that 10,000 gauss (CGS units) equals 1 Tesla (SI units).

Claims 1 and 18, as well as the claims that depend from Claims 1 or 18, include a feature of a soft magnetic underlayer comprising a material having a magnetic moment larger than 1.7 Teslas. A numerical value of magnetic moment is not inherent to a particular material composition of a soft magnetic underlayer, but varies depending on past processing conditions of the soft magnetic underlayer. Neither the Carey et al. nor Shimizu et al. references, taken singly or in combination, teach or suggest a soft magnetic underlayer comprising a material having a magnetic moment larger than 1.7 Teslas. Reconsideration of the rejections under 35 USC 103(a) and allowance of Claims 1-6, 8-22 and 25-28 is therefore requested.

Allowable Subject Matter

The Examiner indicated that Claims 7, 23-24 were objected to as being dependent upon a rejected base claim, but allowable if rewritten in independent form. As argued above, the base claims for claims 7, 23-24 are believed to be allowable, and Claims 7, 23-24 are also believed to be allowable in their

present forms.

Acknowledgement of IDS References not complete

Applicant's Information disclosure statement of 28 August 2003 included references AL and AM on Form PTO-1449. These two references were not initialed by the Examiner. Applicant requests a copy of the Form PTO-1449 with references AL and AM initialled by the Examiner.

Concluding Remarks

The application appears to be in condition for allowance, and favorable action is requested. The Director is authorized to charge any fee deficiency required by this paper or credit any overpayment to Deposit Account No. 23-1123.

Respectfully submitted,

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Enclosure: Pages 357-360 of Cullity's Introduction to Magnetic Materials.

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INTRODUCTION TO MAGNETIC MATERIALS

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INDUCED MAGNETIC ANISOTROPY

10.1 INTRODUCTION

So far in this book we have encountered three kinds of magnetic anisotropy: crystal, shape, and stress. Various other kinds may be induced in certain materials, chiefly solid solutions, by appropriate treatments. These induced anisotropies are of considerable interest both to the physicist, for the light they throw on basic magnetic phenomena, and to the technologist, who may wish to exploit them in the design of magnetic materials for specific applications.

The following treatments can induce magnetic anisotropy:

1. *Magnetic annealing.* This means heat treatment in a magnetic field, sometimes called a *thermomagnetic* treatment. This treatment can induce anisotropy in certain alloys. (Here the term "alloys" includes not only metallic alloys but also mixed ferrites.) The results depend on the kind of alloy:

a) Two-phase alloys. Here the cause of anisotropy is the shape anisotropy of one of the phases and is therefore not basically new. However, it is industrially important because it affects the behavior of some of the Alnico permanent-magnet alloys. It will be described in Chapter 14.

b) Single-phase solid-solution alloys. Here it will be convenient to discuss substitutional and interstitial alloys in separate sections.

2. *Stress annealing.* This means heat treatment of a material that is simultaneously subjected to an applied stress.

3. *Plastic deformation.* This can cause anisotropy both in solid solutions and in pure metals, but by quite different mechanisms.

4. *Magnetic irradiation.* This means irradiation with high-energy particles in a magnetic field.

10.2 MAGNETIC ANNEALING (SUBSTITUTIONAL SOLID SOLUTIONS)

When certain alloys are heat treated in a magnetic field and then cooled to room temperature, they develop a permanent uniaxial anisotropy with the easy axis parallel to the direction of the field during heat treatment. They are then magnetically softer along this axis than they were before treatment. The heat treat-

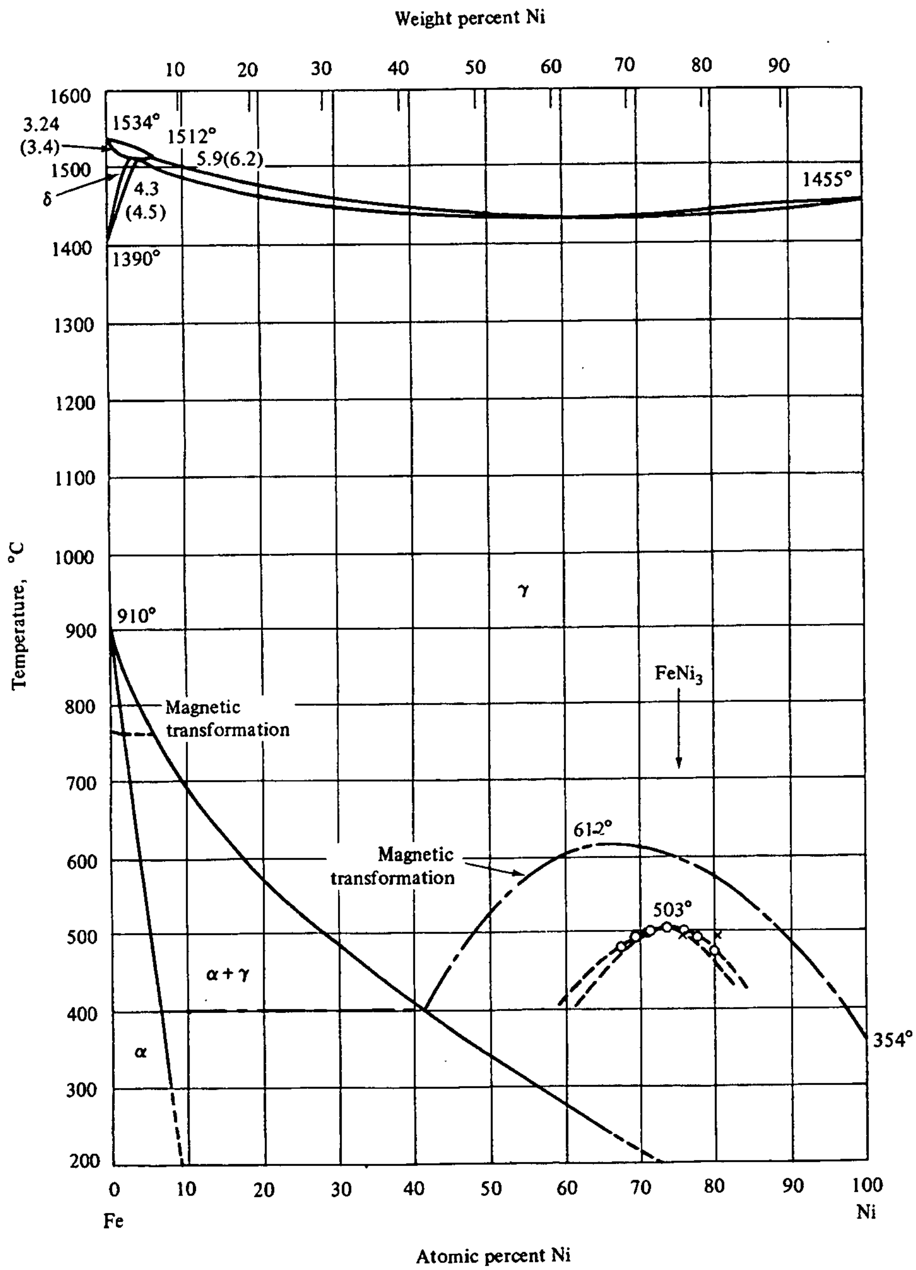

Fig. 10.1 Equilibrium diagram of Fe-Ni alloys. Hansen and Anderko [10.6].

ment may consist only of cooling through a certain temperature range in a field, rather than prolonged annealing; the cooling range or annealing temperature must be below the Curie point of the material and yet high enough, usually above

400 C, so that substantial atomic diffusion can occur. An alternating or unidirectional field is equally effective; all the field does is determine an easy axis, rather than direction, of easy magnetization. The field must be large enough to saturate the specimen during the magnetic anneal, if the resulting anisotropy is to develop to its maximum extent. Usually a field of some 10 Oe or less is sufficient; the material is magnetically soft to begin with, and its permeability at the magnetic-annealing temperature is higher than at room temperature. The term "magnetic annealing" is applied both to the treatment itself and to the phenomenon which occurs during the treatment; i.e., an alloy is often said to magnetically anneal if it develops a magnetic anisotropy during such an anneal. The subject of magnetic annealing has been reviewed by Graham [10.1], Slonczewski [10.2], and Chikazumi and Graham [10.3]; Graham's review contains a large bibliography classified by material composition.

The phenomenon of magnetic annealing was first discovered in 1913 by Pender and Jones [10.4] in an alloy of Fe + 3.5 percent Si. They found that cooling the alloy from about 800° C to room temperature in an alternating field, of about 20 Oe maximum value, caused a substantial increase in maximum permeability. Many years later Goertz [10.5] made measurements on a picture-frame single crystal, with $\langle 100 \rangle$ sides, of an alloy of Fe + 6.5 percent Si; heat treatment in a field increased its maximum permeability from 50,000 to 3.8×10^6, the highest value yet reported for any material.

However, most of the research on magnetic annealing has been devoted to the binary and ternary alloys of Fe, Co, and Ni. Compositions which respond well to magnetic annealing are Fe + 65–85 percent Ni, Co + 30–85 percent Ni, Fe + 45–60 percent Co, and the ternary alloys containing 20–60 percent Ni, 15–35 percent Fe, balance Co. Magnetic annealing has been studied most often in binary Fe-Ni alloys, for which the equilibrium diagram is shown in Fig. 10.1. Both the α (body-centered cubic) and the γ (face-centered cubic) phases are ferromagnetic. There is a large thermal hysteresis in the $\alpha \rightarrow \gamma$ and $\gamma \rightarrow \alpha$ transformations because of low diffusion rates below about 500 C, and the equilibrium shown in Fig. 10.1 is very difficult to achieve. For example, the $\gamma \rightarrow \alpha$ transformation on cooling is so sluggish that it is easy to obtain 100 percent γ at room temperature in alloys containing more than about 35 percent Ni by air cooling γ from an elevated temperature. Hansen and Anderko [10.6] should be consulted for further details.

Typical of the magnetic-annealing results obtained on Fe-Ni alloys are those shown for 65 Permalloy in Fig. 10.2. Comparison of the hysteresis loop of (c) with (a) or (b) shows the dramatic effect of field annealing: the sides of the loop become essentially vertical, as expected for a material with a single easy axis. Conversely, if the loop is measured parallel to the hard axis, i.e., at right angles to the annealing field, the sheared-over, almost linear loop shown in (d) is obtained, where the change in the H scale should be noted. [Specimens for magnetic annealing studies are sometimes in the form of rods, either straight or made into a hollow rectangle in order to have a closed magnetic circuit. In any case it is not usually practical to apply a field transverse to the rod axis because of the very large demagnetizing factor, equal to 2π, in that direction. Instead, a direct cur-

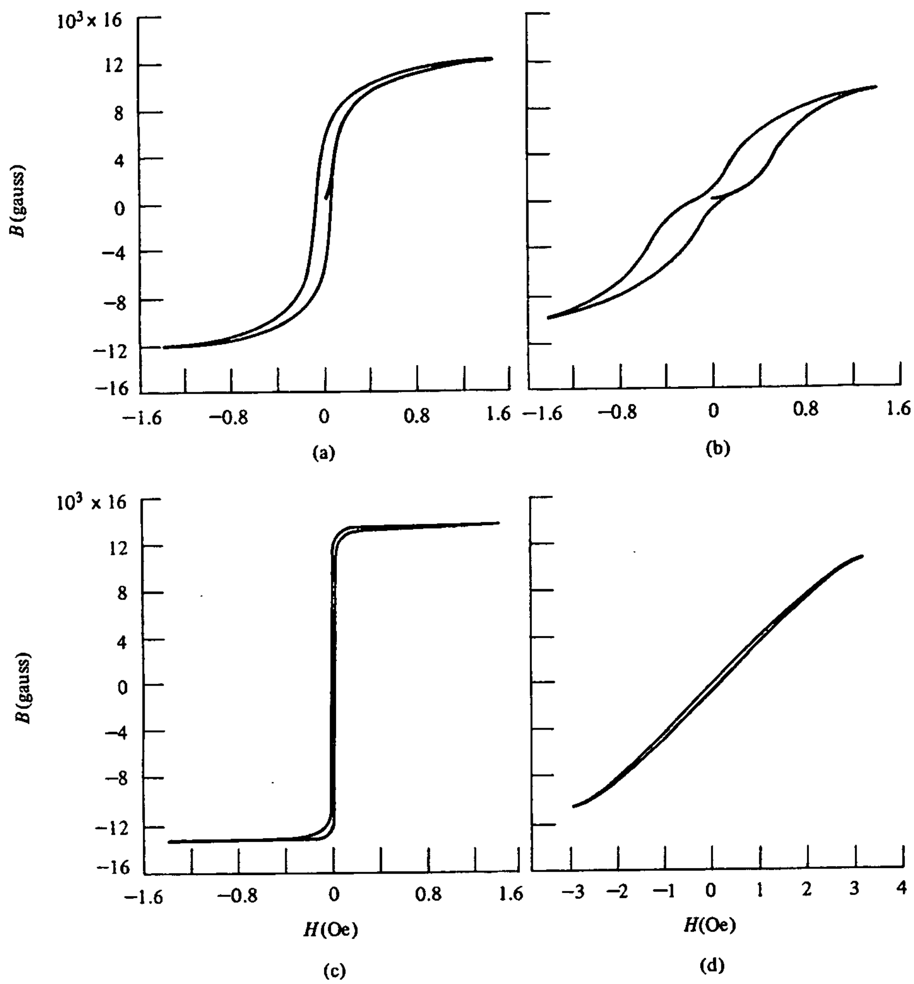

Fig. 10.2 Hysteresis loops of a 65 Ni-35 Fe alloy after various heat treatments: (a) annealed at 1000° C and cooled quickly, (b) annealed at 425° C or cooled slowly from 1000° C, (c) annealed at 1000° C and cooled in a longitudinal field, (d) same as (c) but with a transverse field. Bozorth [G.4].

rent is passed along the rod axis during the anneal, producing a circular field around the axis (Section 1.6). This field can easily be made strong enough to saturate the specimen circumferentially, except for a relatively small volume near the axis. If a magnetic measurement is subsequently made parallel to the axis in the usual way, the measurement direction is then at right angles to that of the annealing field. A longitudinal annealing field is achieved simply by wrapping the rod with a helical magnetizing winding, suitably protected by an insulator that will withstand the annealing temperature. If the specimen is in the form